

***Dikerogammarus villosus* (Crustacea: Amphipoda): another invasive species in Lake Geneva**

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***Dikerogammarus villosus* (Crustacea: Amphipoda): another invasive species in Lake Geneva.** - According to field observations performed in 2002 and 2003, the amphipod species *Dikerogammarus villosus* (Sowinsky, 1894) is now well established in Lake Geneva. The author predicts that this and future invasions by *D. villosus* will have serious effects on freshwater ecosystems.

Key-words: *Dikerogammarus villosus* - amphipod - biological invasion - ecological impact.

INTRODUCTION

The Ponto-Caspian amphipod (crustacean) *Dikerogammarus villosus* (Sowinsky, 1894) is currently among the most successful invaders of aquatic ecosystems in Europe (Dick & Platvoet, 2000; Bij de Vaate *et al.*, 2002). Being a native of the Ponto-Caspian Region, this species is widely distributed in the Black Sea, Azov Sea and Caspian Sea basins, from the lower reaches and delta of the Danube River to the Volga River (Carausu *et al.*, 1955). After invading the Danube in Austria in 1989, *D. villosus* was collected for the first time in the upper reaches of the river Danube in 1992 (Neseman *et al.*, 1995). In 1994 the species was recorded in the lower Rhine River (Bij de Vaate & Klink, 1995). Two years later *D. villosus* was discovered in the Moselle River and in 1997 for the first time in the French hydrosystem in the Saone River (Devin *et al.*, 2001; Bollache, 2003). In 1998 it was recorded in the Rhone River and in the Meuse River. Two years later *D. villosus* was detected in the Seine River (in 2000) and three years later in the Loire River (in 2001). Field surveys and laboratory experiments indicate that the ecological impact of a *D. villosus* invasion may be severe (Van der Velde *et al.*, 2000). For example, Dick and Platvoet (2000) have shown in Netherland freshwaters that *D. villosus* was rapidly eliminating *Gammarus duebeni* (Lilljeborg, 1851) and *Gammarus tigrinus* (Sexton, 1939), respectively, a native and an invader species from North America. In addition, *D. villosus*, being larger than the other freshwater amphipod species in western Europe, is known to prey on numerous macroinvertebrates (Dick *et al.*, 2002), and an isotope analysis ($\delta^{15}\text{N}$) indicated that it

is active at the same trophic level as fish species (Marguillier, 1998). My study, based on field observations in 2002 and 2003, demonstrates that *D. villosus* is now established in Lake Geneva.

MATERIAL AND METHODS

Four sites in France were sampled (Fig. 1). Yvoire, Corzent, Thonon-les-Bains and Lugrin. Gammarids were collected by kick-sampling using a hand net. *D. villosus* was identified by using the key of Carausu *et al.* (1955). Only adult individuals were

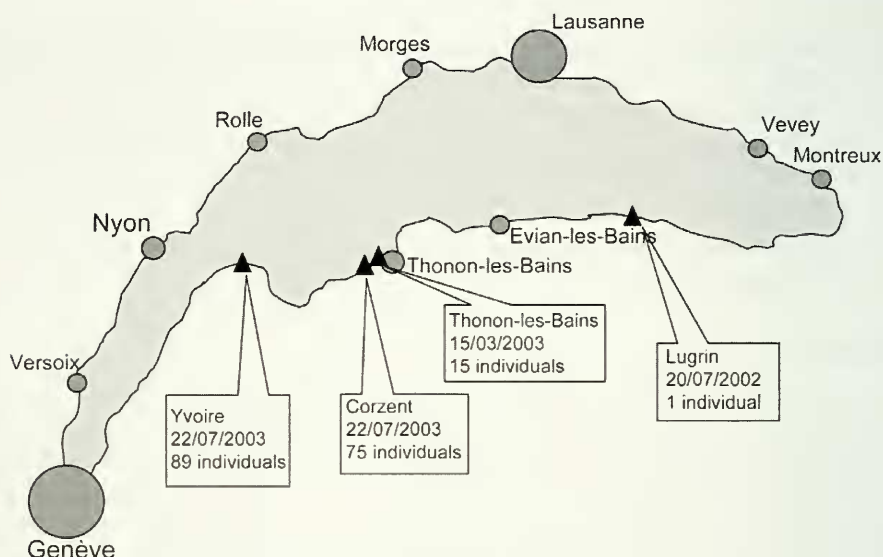


FIG. 1

Map of Lake Geneva with sampling sites (full triangles), and number of *D. villosus* specimens collected at each site on certain dates.

examined, as most of the species-specific diagnostic characters are fully developed and more obvious in these specimens. *Dikerogammarus* can easily be separated from *Gammarus* by the striking difference in the morphology of their third uropods. In the genus *Gammarus* the inner and outer rami are well developed, with the inner ramus varying from 1/3 to 3/5 of the length of the outer ramus (Fig. 2a), while in the genus *Dikerogammarus* the inner rami are vestigial (Fig. 2b). *D. villosus* males and females bear two protuberances with spines on the back of the first and second urosome (see fig. 3), and short setae on the peduncle of the second antennae. Moreover there is strong sexual dimorphism in the flagellum of the second antennae, which is distally much more densely setose in males than in females (Fig. 2c). Long and dense setae are also present on the first and second gnathopods of males (Fig. 2d).

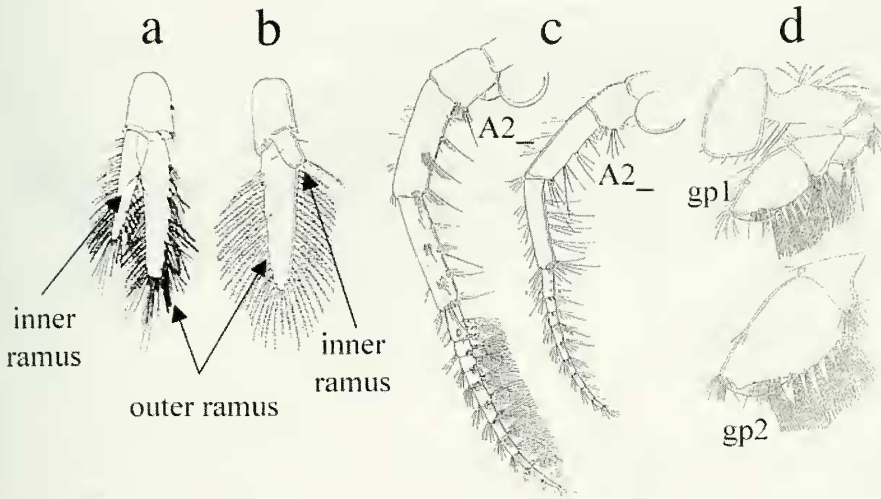


FIG. 2

(a) *Gammarus pulex*, third uropod after Roux, 1967; (b) *Dikerogammarus villosus*, third uropod after Carausu *et al.*, 1955; (c) *D. villosus* male and female, second antenna after Carausu *et al.*, 1955; (d) *D. villosus* male, first and second gnathopods after Carausu *et al.*, 1955.

RESULTS

D. villosus was observed for the first time in Lake Geneva during the summer of 2002 at Lugrin (France); one specimen was found among specimens of the native gammarid, *Gammarus fossarum*. In 2003 *D. villosus* was recorded at the other three French sites prospected, Yvoire harbour, Thonon-les-Bains (INRA station) and Concert harbour (Fig. 3), without any other gammarid species present and was found to be very abundant in rockpools and under porous stones, hanging on tightly to the bumps on the stones.

DISCUSSION

The present and previous data allow us to attribute the arrival of *D. villosus* to Lake Geneva between the years 2001 and 2002. The reason for this recent massive invasion of a Ponto-Caspian species in central and western Europe is the increasing ionic content of large European rivers in the last decades, caused by industrial and agricultural pollution (Jazdzewski & Konopacka, 2002). Another cause is explained in the "invasional meltdown hypothesis" (Ricciardi & Rasmussen, 1998; Simberloff & Von Holle, 1999; Ricciardi, 2001) according to which a previously invasion of the zebra mussel *Dreissena polymorpha* (Pallas, 1771) in the central and western European freshwater ecosystem may have facilitated the invasion of *D. villosus* by providing substrate, food and shelters. The same scenario is invoked to explain the establishment and dispersal of *Chaetogammaris ischnus* (Stebbing, 1906) another Ponto-Caspian amphipod, in the Great Lakes of North America (Witt *et al.*, 1997; Dermott *et al.*, 1998;

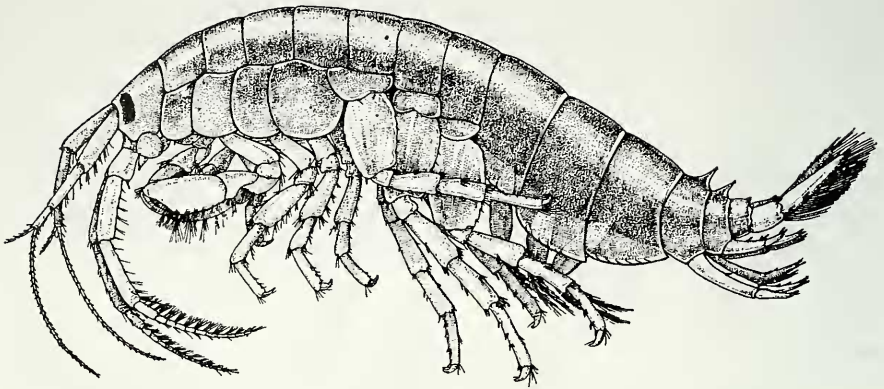


FIG. 3

Dikerogammarus villosus adult male after Carausu *et al.*, 1955, modified after Bollache, 2003.

Nalepa *et al.*, 2001). Dick *et al.* (2002) have recently shown in the Netherlands that predation by the invader *D. villosus* was significantly greater than predation by the native amphipod species *G. duebeni*. The predatory capacity of *D. villosus*, together with its high ability to disperse by anthropogenic means, lead I to predict that *D. villosus* will soon be present in the others lakes of Switzerland, and that this poses a serious threat for the biodiversity of freshwater ecosystems in Europe.

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